**Thesis Title:**

*Ultra-fast Alternating Current Potential Drop Measurement System for Materials Characterization and Precision Impedance Analyzer for Eddy Current Measurement*

**Abstract:**

*The alternating current potential drop method (ACPD) with four-point probe injects alternating current into the sample under test from the two outer drive pins and measures the voltage (potential) drop between the two inner pick-pins. This method can be used to measure electrical conductivity, linear permeability, coating depth, as well as crack size. However, the measurement speed and accuracy of present ACPD system need to be dramatically improved.*

*This work discusses the design, implementation and test of a novel ultra-fast standalone ACPD system.  New and powerful hardware including high current transconductance amplifier and low noise amplifier provide a sound foundation for nearly perfect system level noise performance; new time domain to frequency domain conversion method increases the measurement speed without sacrificing noise performance. A general purpose calibration method is introduced so that the accuracy of this system is guaranteed.*

*With the development and introduction of this new ACPD instrument, ACPD method has evolved from a laboratory NDE method to a full blown technique that is ready for real world application.*

*The last chapter of this thesis discusses a simple but powerful lock-in amplifier based precision impedance analyzer. This impedance analyzer provides an economical solution to eddy current testing that requires highest precision.*